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## TENT COOPERATION TRE. Y

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents  
United States Patent and Trademark  
Office  
Box PCT  
Washington, D.C.20231  
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 04 March 2000 (04.03.00)	
International application No. PCT/GB99/02117	Applicant's or agent's file reference P 60029 WO
International filing date (day/month/year) 02 July 1999 (02.07.99)	Priority date (day/month/year) 04 July 1998 (04.07.98)
Applicant ASHLEY, Timothy et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

03 February 2000 (03.02.00)

☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

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The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer S. Mafla Telephone No.: (41-22) 338.83.38
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## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

REGAN, Heather  
Harrison Goddard Foote  
11C Compstall Road  
Marple Bridge  
Stockport SK6 5HH  
ROYAUME-UNI

Date of mailing (day/month/year) 08 November 2000 (08.11.00)	<b>IMPORTANT NOTIFICATION</b>
Applicant's or agent's file reference P 60029 WO	
International application No. PCT/GB99/02117	International filing date (day/month/year) 02 July 1999 (02.07.99)

1. The following indications appeared on record concerning:	
<input type="checkbox"/> the applicant	<input type="checkbox"/> the inventor <input checked="" type="checkbox"/> the agent <input type="checkbox"/> the common representative
Name and Address REGAN, Heather Harrison Goddard Foote 1 Stockport Road Marple SK6 6BD United Kingdom	State of Nationality
	State of Residence
	Telephone No. 0161 427 7005
	Facsimile No. 0161 427 7026
Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:	
<input type="checkbox"/> the person	<input type="checkbox"/> the name <input checked="" type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence
Name and Address REGAN, Heather Harrison Goddard Foote 11C Compstall Road Marple Bridge Stockport SK6 5HH United Kingdom	State of Nationality
	State of Residence
	Telephone No. 0161 427 7005
	Facsimile No. 0161 427 7026
Teleprinter No.	
3. Further observations, if necessary:	
4. A copy of this notification has been sent to:	
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer  Maria Victoria CORTIELLO
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

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## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>P 60029 WO</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/GB 99/ 02117</b>	International filing date (day/month/year) <b>02/07/1999</b>	(Earliest) Priority Date (day/month/year) <b>04/07/1998</b>
Applicant <b>THE SECRETARY OF STATE FOR DEFENCE...et al.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

## 1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

4b

☐ None of the figures.

## INTERNATIONAL SEARCH REPORT

International Application No

CT/GB 99/02117

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 7 H01L33/00 G01N21/35

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01L G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PHILLIPS C ET AL: "Recent advances in In(As,Sb) SLS and QW LEDs for the 3-10 micron region"</p> <p>LIGHT-EMITTING DIODES: RESEARCH, MANUFACTURING, AND APPLICATIONS II, SAN JOSE, CA, USA, 28-29 JAN. 1998, vol. 3279, pages 154-160, XP002115199</p> <p>Proceedings of the SPIE - The International Society for Optical Engineering, 1998, SPIE-Int. Soc. Opt. Eng, USA</p> <p>ISSN: 0277-786X</p> <p>page 158, paragraph 3III - page 159; figures 5-9</p> <p style="text-align: center;">---</p> <p style="text-align: center;">-/--</p>	1,6-9



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

\* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

14 September 1999

Date of mailing of the international search report

30/09/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
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Authorized officer

De Laere, A

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/02117

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>ELLIOTT C T: "New infrared and other applications of narrow-gap semiconductors" INFRARED TECHNOLOGY AND APPLICATIONS XXIV, SAN DIEGO, CA, USA, 19-24 JULY 1998, vol. 3436, pt.1-2, pages 763-775, XP002115200 Proceedings of the SPIE - The International Society for Optical Engineering, 1998, SPIE-Int. Soc. Opt. Eng, USA ISSN: 0277-786X page 764, paragraph 3 - page 766 page 771, paragraph 6 - page 774 ----</p>	1,6-9
A	<p>ASHLEY T: "ELECTRONIC AND OPTOELECTRONIC DEVICES IN NARROW-GAP SEMICONDUCTORS" INSTITUTE OF PHYSICS CONFERENCE SERIES, no. 144, 1 January 1995 (1995-01-01), pages 345-352, XP000607745 ISSN: 0951-3248 page 348, paragraph 4 - page 349 page 349, line 7,8 ----</p>	1,6-9
A	<p>WANG C H ET AL: "DETECTION OF NITROGEN DIOXIDE USING A ROOM TEMPERATURE OPERATION MID-INFRARED INSB LIGHT EMITTING DIODE" ELECTRONICS LETTERS, vol. 34, no. 3, 5 February 1998 (1998-02-05), page 300/301 XP000773742 ISSN: 0013-5194 the whole document -----</p>	1,6-9

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P 60029 WO	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB99/02117	International filing date (day/month/year) 02/07/1999	Priority date (day/month/year) 04/07/1998
International Patent Classification (IPC) or national classification and IPC H01L33/00		
Applicant THE SECRETARY OF STATE FOR DEFENCE...et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 7 sheets, including this cover sheet.

- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand  03/02/2000	Date of completion of this report  01.08.2000
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer  Krause, J  Telephone No. +49 89 2399 2829 

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB99/02117

**I. Basis of the report**

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

**Description, pages:**

1,3-14	as originally filed		
2,2a	as received on	07/07/2000 with letter of	07/07/2000

**Claims, No.:**

1-16	as received on	07/07/2000 with letter of	07/07/2000
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**Drawings, sheets:**

1/6-6/6	as originally filed
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2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB99/02117

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Yes: Claims 7 - 16
	No: Claims 1 - 6
Inventive step (IS)	Yes: Claims 9 - 16
	No: Claims 1 - 8
Industrial applicability (IA)	Yes: Claims 1 - 16
	No: Claims

**2. Citations and explanations**

**see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

**see separate sheet**

**Concerning Section V:**

**I. Claim 1:**

1. The document WO-A-97/13282 (= D1), which is not cited in the International Search Report, is considered to represent the most relevant state of the art. It describes an infrared light emitting diode arrangement (cf. page 5, first and second paragraphs, page 9, first paragraph, to page 10, second paragraph, and Figs 1, 2, and 9), which comprises an infrared light emitting diode (5) which emits positive luminescence when forward biased and emits negative luminescence when reverse biased, and a drive means (C). The drive means is suitable for supplying an alternating forward and reverse bias input to the light emitting diode. The feature, that the levels of the forward and reverse bias applied by the drive means are set so that at the forward input level the change in output power of the LED with temperature is substantially equal to and cancels out the change in output power of the LED with temperature at the reverse bias input level over a selected temperature range so that the difference in output power between the positive luminescence and the negative luminescence of the light emitting diode is stabilised with respect to temperature, relates to the method of operating the device rather than to the device itself to which the claim is directed (see remarks concerning section VIII below). The drive means according to document D1 is in any case suitable to supply such an input.
2. As a consequence, all the device features of claim 1 are anticipated by document D1, and therefore claim 1 is not considered to meet the requirements of Article 33(2) and (3) PCT.

**II. Claims 2 to 8:**

1. The additional features of dependent claims 2 to 4 relate to the method of operating the device and not to the device itself (cf. remarks concerning section VIII below). Concerning the infrared light emitting diode arrangement themselves, the drive means according to document D1 are suitable to drive the IR-LEDs in the way specified in claims 2 to 4. Therefore all the device features of claims 2 to 4 are known

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB99/02117

from document D1, and claims 2 to 4 are not considered to meet the requirements of Article 33(2) and (3) PCT, accordingly.

2. The additional features of claims 5 and 6 are known from document D1 (cf. page 6, first paragraph, to page 7, second paragraph, and Figs 3 and 4). Claims 5 and 6 do therefore not appear to meet the requirements of Article 33(2) and (3) PCT.
3. The article by C.H. Wang et al.: "Detection of nitrogen dioxide using a room temperature operation mid-infrared InSb light emitting diode", which appeared in Electronics Letters, vol. 34, No. 3 (5 February 1998), pages 300 and 301, XP000773742, ISSN: 0013-5194(= D2), describes a gas sensor including an infrared light emitting diode arrangement (cf. page 300, right column, second paragraph, to page 301, right column, second paragraph, and Fig. 1). Since the light emitting diode is operated with a square pulse current, there must be a drive means, and it is also mentioned that reverse bias leads to a negative emission spectrum. However, it is not explicitly mentioned in document D2 that the infrared light emitting diode is alternatingly forward and reverse biased.
4. The person skilled in the art would know that negative luminescence is advantageous from the article by C. Phillips et al.: "Recent advances in In(As,Sb) SLS and QW LEDs for the 3-10 micron region", which appeared in Proceedings of the SPIE - The International Society for Optical Engineering, 1998, SPIE-Int. Soc. Opt. Eng, US, vol. 3279, pages 154-160, XP002115199, ISSN: 0277-786X relating to the conference: Light-emitting diodes: Research, Manufacturing, and Applications II, San Jose, California, US, 28-29 January 1998 (= D3). The article discusses the properties of negative luminescent diodes (cf. page 155, second and third paragraphs).
5. The person skilled in the art would therefore routinely provide a drive means as in document D1, which is able to provide positive and reverse bias, also in a gas sensor according to document D2. He would thus obtain a device with all the features of claims 7 and 8, and therefore claims 7 and 8 are not considered to meet the requirement of Article 33(3) PCT.

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB99/02117

**III. Claims 9 to 16:**

1. Document D2 describes a method of operating an infrared light emitting diode which emits positive luminescence when forward biased and emits negative luminescence when reverse biased, comprising supplying an alternating bias input to the light emitting diode. Document D1 describes an IR-LED which can be driven with forward and with reverse bias as well.
2. The subject-matter of claim 9 differs from the contents of document D2 in that the bias is alternating forward and reverse, which is not stated in document D2, and in that the difference in output power between positive and negative luminescence of the light emitting diode is stabilised with respect to temperature. With respect to document D1 the subject-matter of claim 9 differs in that the forward and reverse biases need not be alternating and in that the power difference is stabilised with respect to temperature.
3. Since none of the documents cited in the International Search Report refers to temperature stabilisation of output power, the person skilled in the art would not be tempted to use alternately positive and negative luminescence and to keep the power difference constant with respect to temperature variations. Claim 9 is therefore considered to meet the requirements of Article 33(2) and (3) PCT.
4. Claims 10 to 16 depend on claim 9, ie they comprise all the features of claim 9. Since claim 9 is considered to meet the requirements of Article 33(2) and (3) PCT, also claims 10 to 16 are considered to meet these requirements.

**Concerning Section VIII:**

1. Claims 1 to 4 are directed to a device but tend to define the device in terms of a method for its operation. The operation characterises the device only in the respect of providing the possibility of performing said operation but not in the sense that the operation is actually performed. Generally a device should also be protected when not in operation. As a consequence, the claims 1 to 4 are not clear (Article 6 PCT) and should be replaced by method claims, since the device features are already known.
2. The word "substantially" employed in claims 1, 3, 9, and 11 obscures the scope of protection sought by the claims (Article 6 PCT).



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>7</sup> :

H01L 33/00, G01N 21/35

A1

(11) International Publication Number:

WO 00/02263

(43) International Publication Date:

13 January 2000 (13.01.00)

(21) International Application Number: PCT/GB99/02117

(22) International Filing Date: 2 July 1999 (02.07.99)

(30) Priority Data:

9814462.9

4 July 1998 (04.07.98)

GB

(71) Applicant (for all designated States except US): THE SECRETARY OF STATE FOR DEFENCE [GB/GB]; Defence Evaluation & Research Agency, Ively Road, Farnborough, Hampshire GU14 6TD (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): ASHLEY, Timothy [GB/GB]; 39 Whitborn Close, Malvern, Worcestershire WR14 2SP (GB). CROWDER, John, Graham [GB/GB]; 1 Clerwood View, Edinburgh EH12 8PH (GB). MANNHEIM, Volker, Paul [DE/DE]; Am Kirchplatz 25, D-26441 Jever (DE). SMITH, Stanley, Desmond [GB/GB]; Tree Tops, 29 Gillespie Road, Colinton, Edinburgh EH13 0NW (GB).

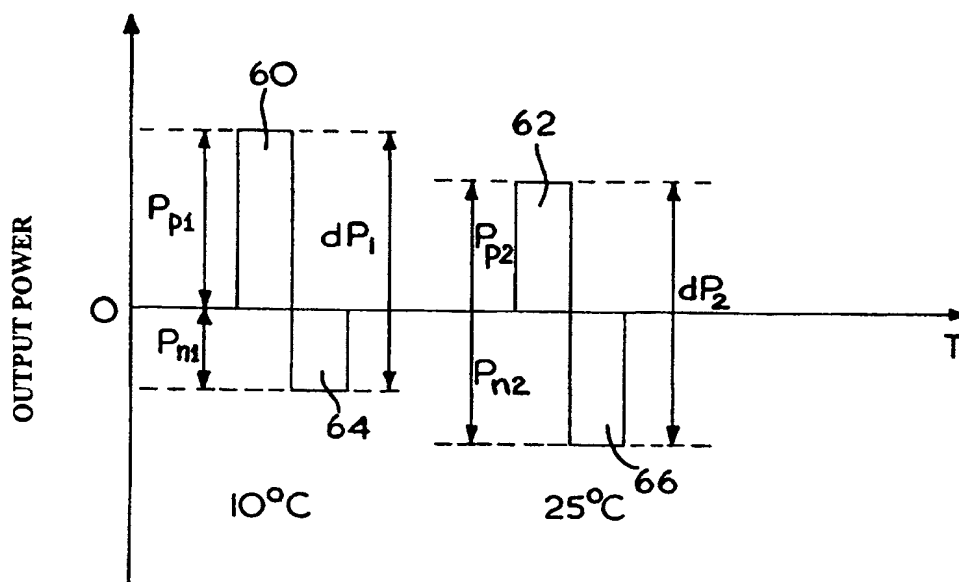
(74) Agent: REGAN, Heather; Harrison Goddard Foote, 1 Stockport Road, Marple SK6 6BD (GB).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

(54) Title: INFRARED LIGHT EMITTING DIODES



## (57) Abstract

An infrared light emitting diode arrangement comprising an infrared light emitting diode which emits positive luminescence when forward biased and emits negative luminescence when reverse biased. The diode is driven by an alternating forward and reverse bias input so that the difference in output power between the positive luminescence and the negative luminescence of the light emitting diode is stabilised with respect to temperature. The infrared light emitting diode arrangement has particular application as a source in gas sensors and reduces or eliminates temperature control requirements for infrared light emitting diode sources.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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stabilising and/or monitoring temperature adds expense and complexity to the operation of infrared LEDs in gas detection applications.

The object of the present invention is to provide an infrared LED  
5 arrangement which does not require significant temperature stabilisation in order to operate in a stable manner.

Accordingly, a first aspect of the present invention provides an infrared light emitting diode arrangement comprising;

10 an infrared light emitting diode which emits positive luminescence when forward biased and negative luminescence when reverse biased, and

a drive means for supplying an alternating forward and reverse bias input to the light emitting diode so that the  
15 difference in output power between the positive luminescence and the negative luminescence of the light emitting diode is stabilised with respect to temperature.

According to a second aspect of the present invention there is provided a method of operating an infrared light emitting diode which emits positive luminescence in forward bias and negative luminescence in  
20 reverse bias, the method comprising supplying an alternating forward and reverse bias input to the light emitting diode so that the difference in output power between the positive luminescence and the negative luminescence of the light emitting diode is stabilised with respect to temperature.

25 The component of the output power emitted from the light emitting diode (LED) which varies with the alternating forward and reverse bias input therefore has a constant difference between the maximum (positive luminescence) and the minimum (negative luminescence) output power in each cycle of positive and negative luminescence, over a selected

Replaced by 44234



**CLAIMS**

1. An infrared light emitting diode arrangement comprising;  
  
an infrared light emitting diode which emits positive  
luminescence when forward bias and emits negative  
luminescence when reverse biased, and  
  
a drive means for supplying an alternating forward and  
reverse bias input to the light emitting diode so that the  
difference in output power between the positive  
luminescence and the negative luminescence of the light  
emitting diode is stabilised with respect to temperature.
2. An arrangement according to claim 1 wherein the alternating forward  
and reverse bias input alternates regularly.
3. An arrangement according to claim 1 or claim 2 wherein the period  
and intensity of the forward bias input is substantially the same in  
consecutive cycles of positive luminescence and the period and  
intensity of the reverse bias input is substantially the same in  
consecutive cycles of negative luminescence.
4. An arrangement according to any one of the preceding claims  
wherein at the forward bias input level the change in output power of the  
LED with temperature is substantially equal to and cancels out the  
change in the output power of the LED with temperature at the reverse  
bias input level, over a selected temperature range.
5. An arrangement according to any one of the preceding claims  
wherein the reverse bias input applied to the LED is such that it  
generates the maximum level of negative luminescence in the LED, at  
the maximum temperature of a selected temperature range of operation.

6. An arrangement according to any one of the preceding claims wherein the light emitting diode emits radiation at infrared wavelengths in the range of 3 to 13 microns.
7. An arrangement according to any one of the preceding claims wherein the light emitting diode is formed from a narrow bandgap semiconductor material.
8. A sensor including an infrared light emitting diode arrangement according to any of the preceding claims.
9. A sensor according to claim 8 wherein the sensor is a gas sensor.
10. A method of operating an infrared light emitting diode which emits positive luminescence when forward biased and emits negative luminescence when reverse biased, comprising supplying an alternating forward and reverse bias input to the light emitting diode so that the difference in output power between positive luminescence and negative luminescence of the light emitting diode is stabilised with respect to temperature.
11. A method according to claim 10 wherein the alternating forward and reverse bias input alternates regularly.
12. A method according to claim 10 or claim 11 wherein the period and intensity of the forward bias input is substantially the same in consecutive cycles of positive luminescence and the period and intensity of the reverse bias input is substantially the same in consecutive cycles of negative luminescence.
13. A method according to any one of claims 10 to 12 wherein the change in the output power of the LED with temperature at the forward bias input level is substantially equal to and cancels out the change in the output power of the LED with temperature at the reverse bias input level, over a selected temperature range.

14. A method according to any one of claims 10 to 13 wherein the reverse bias input applied to the LED is such that it generates the maximum level of negative luminescence in the LED, at the maximum temperature in a selected temperature range of operation.
- 5 15. A method according to any one of claims 10 to 14 wherein the light emitting diode emits radiation at infrared wavelengths in the range of 3 to 13 microns.
16. An infrared light emitting diode arrangement substantially as hereinbefore described with reference to any one of the accompanying
- 10 Figures.
17. A method of operating an infrared light emitting diode substantially as hereinbefore described with reference to any one of the accompanying drawings.